

Worldwide Pollution Control Association

**Dry Scrubbing
O&M Training**

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Safety Aspects in the use of Carbonaceous Sorbents for Entrained-Phase Adsorption

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Safety Considerations

- The activated carbons employed consist primarily of carbon, which in principle makes them combustible.
- Due to their high surface area and porosity, these activated carbons also react with oxygen, releasing heat.
- Like any other combustible, pulverized activated carbons can be explosible under certain circumstances.



Good News

- Volatiles are released during production of Activated Carbons (900°C)
- Typical bituminous coal PC boiler at an AC injection rate of 10 lb/MMACF would be <1% of ash



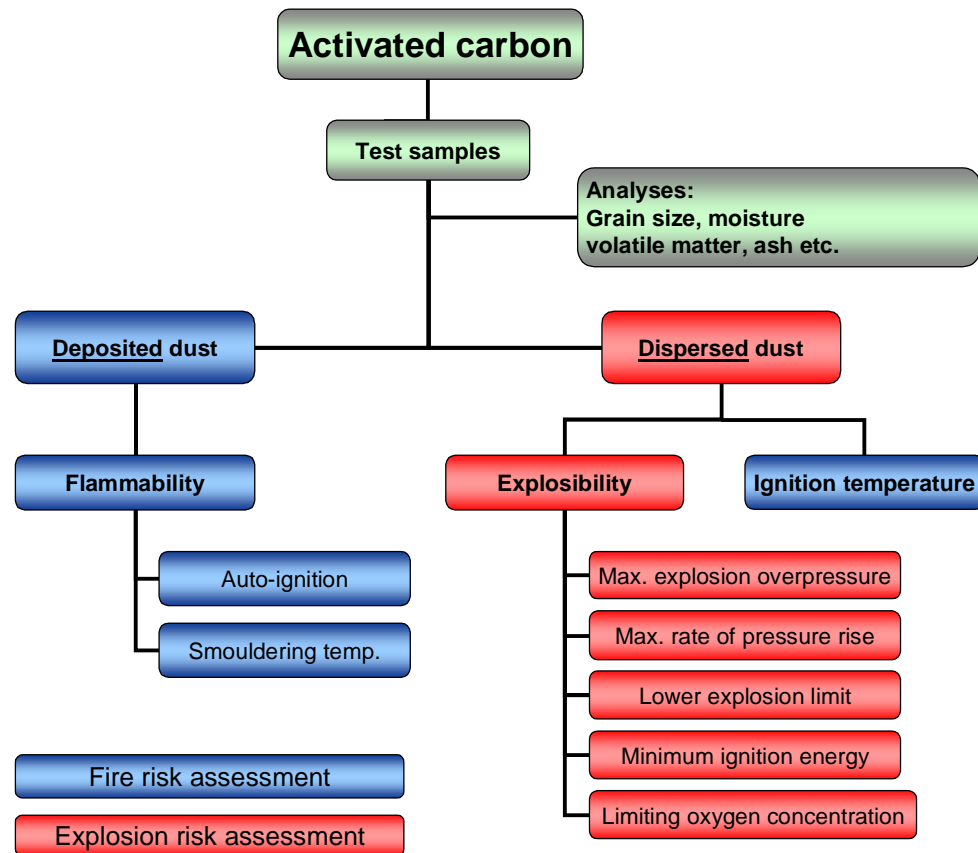


Good News

- Over 400 WTE plants operating with carbon based technologies
- No reported incidences



Evaluation of Safety Behavior





Typical Combustion Parameters

	HOK Pulverized	HOK Super	typical pulverized coal
Moisture, wt%	0.5	0.5	11
Top grain size, mm	0.4	0.13	0.5
d ₅₀ , μm	63	24	55
Combustibility class (100 °C)	BZ2	BZ3	BZ4
Self-ignition temperature, °C	250	250	110
Smoldering temperature, °C	>450	>450	240
Ignition temperature, °C	560	590	450
Lower Explosion Limit, at 20 °C, g/m ³	60	60	40
Maximum overpressure, bar	7.6	8.6	9
KSt value, bar-m/s	96	92	150
Dust explosion class	St 1	St1	St1
Minimum ignition energy, Joules	200-500	200-500	0.185-0.245



Explosion Risk

An explosion hazard only exists if the following conditions are fulfilled simultaneously:

- Activated carbon is dispersed in air, in a concentration range between lower and upper explosive concentration limits **and**
- The limiting oxygen concentration required for an explosion of the mixture is exceeded **and**
- An ignition source sufficient for ignition of the dust/air mixture is present



Safety Aspects in Respect of Entrained-Phase Adsorption with AC

Explosion

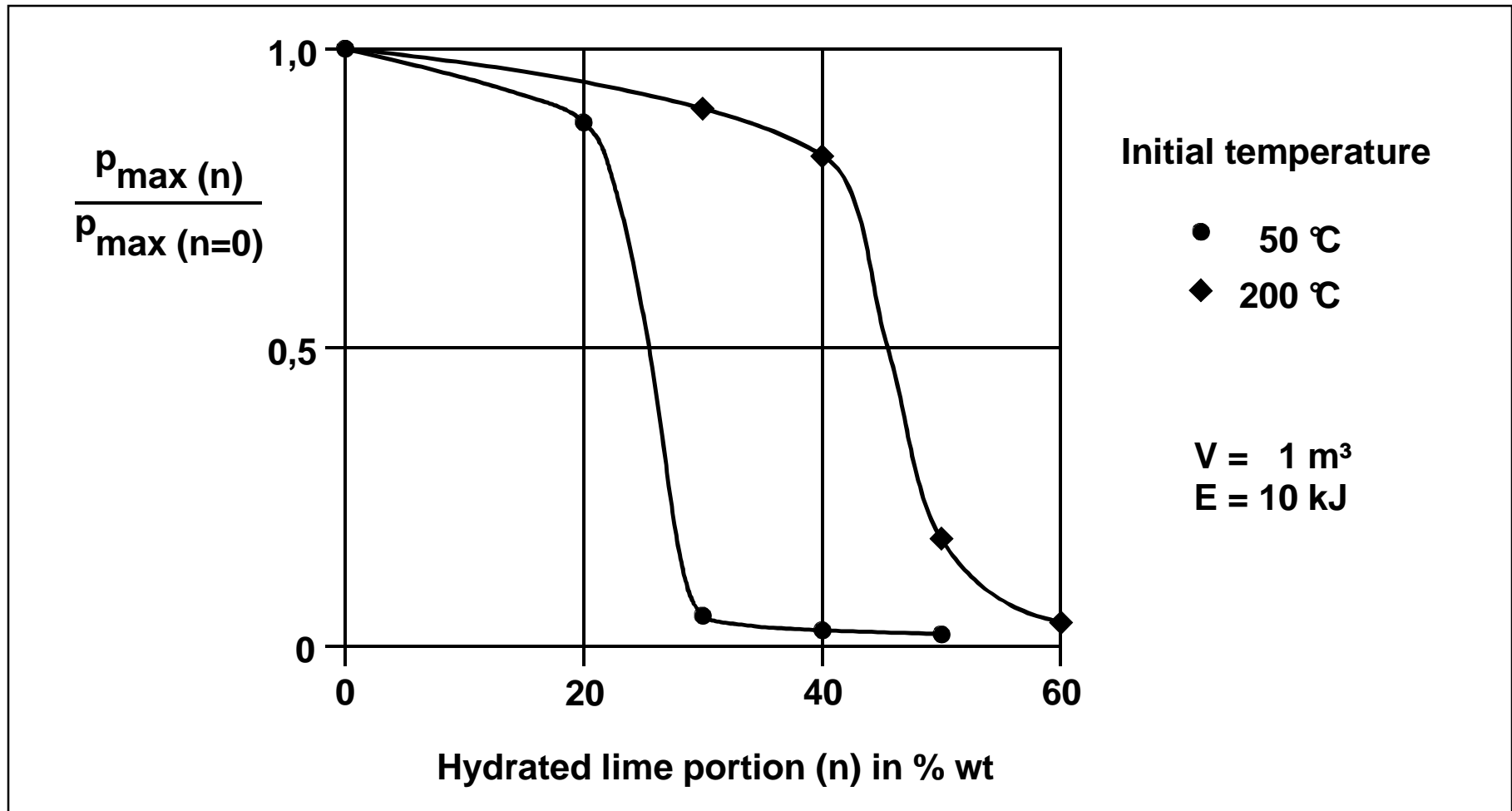
Caused if simultaneously:

- Dust is whirled up and concentration is within the explosion limit **and**
- O₂-content exceeds the oxygen limiting concentration **and**
- Ignition source has sufficient energy

Prevented by:

- Exclusion of efficient ignition sources **or**
- Operation below the temperature-dependent O₂ limiting concentration (at 200 °C, 12 % vol.) **or**
- Inert portion (e.g. process dusts or inert additives dosed)

Influence of the inert portion on explosibility





In order to avoid fires in beds or deposits containing carbon, two aspects must be taken into account

- the fire risk from ignition sources
- the potential for auto-ignition.

To avoid auto-ignition, the following measures are recommended:

- Avoid major ash deposits in the process stream, for example, through continuous ash discharge from the ESP or baghouse hoppers.
- Preclude low-velocity air flows through the stored carbon or in spent solids. Low-velocity gas flows involve the danger that the reaction heat developed in the gas flow channel causes local overheating in the bed.



Safety Aspects in Respect of Entrained-Phase Adsorption with AC

Fire

Caused by:

- Ignition sources introduced (e.g. sparks with high energy content, etc.) or
- Spontaneous ignition in the case of larger dust deposits

Prevented by:

- Prevention of efficient ignition sources being fed (e.g. by upstream coarse dust separator, gas scrubber, etc.)
- Prevention of larger dust deposits (e.g. by continuous dust discharge appropriate structural design, etc.)



Good Design/Housekeeping

- Cleanup
- Grounding
 - Static electric
- Confined space
 - Adsorbs oxygen
- Dust protected motors and switch gear
 - Do not need explosion or dust ignition proof
 - TEFC motors recommend



Good Operating Practice

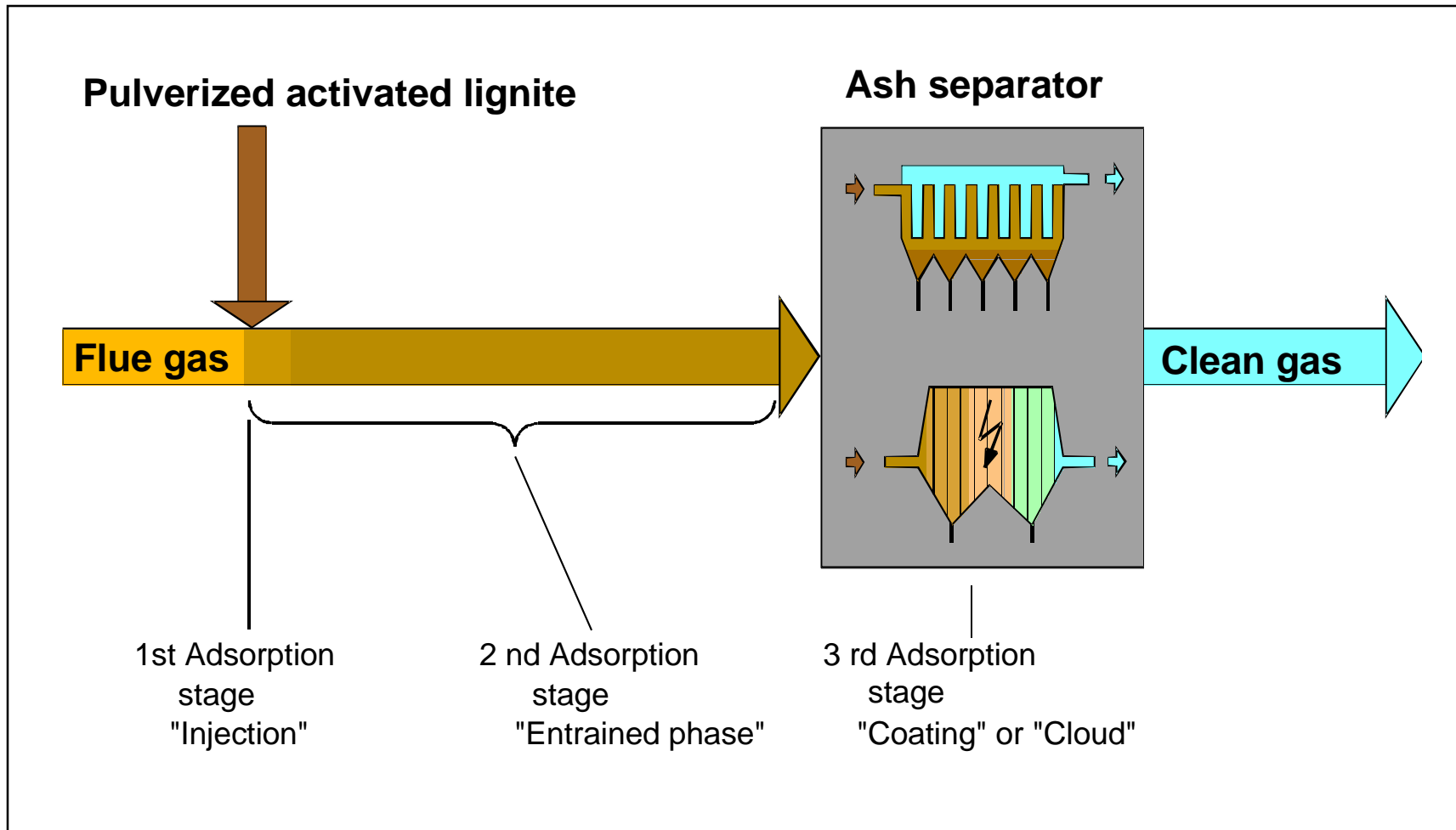
- Avoid direct flame or heat
 - **Welding etc.**
- Keep hoppers free flowing
 - **Empty during outages**



Electric Forces

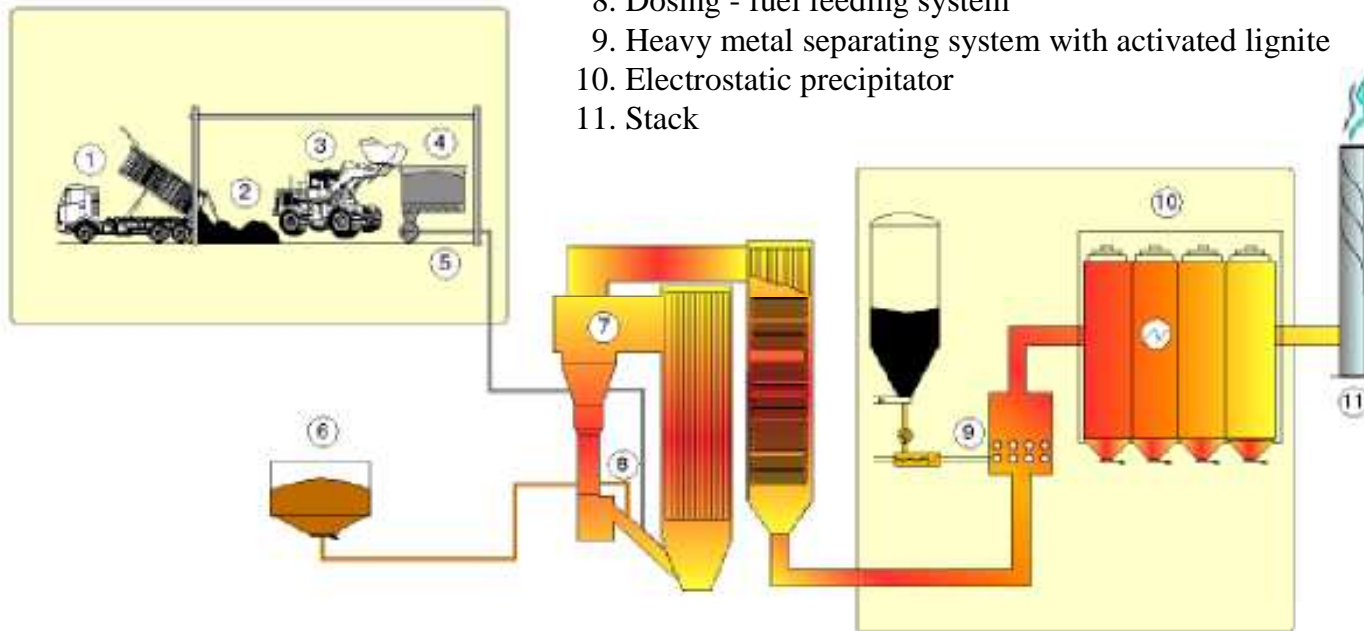
- Possible ignition sources include static build-up from conveying solids, spark discharge in an ESP, hot equipment surfaces, and carryover of burning fuel from plant upset conditions.
- Personnel protection from shock

Typical Entrained Phase Design



HOK Addition for Hg-Separation in an Industrial Power Plant

1. Sewage sludge transport (truck / container)
2. Sewage sludge storage
3. Wheel loader
4. Feeding hopper / discharging system with screw
5. Solids pump
6. Raw lignite bunker
7. Circulating fluidized-bed firing system
8. Dosing - fuel feeding system
9. Heavy metal separating system with activated lignite
10. Electrostatic precipitator
11. Stack



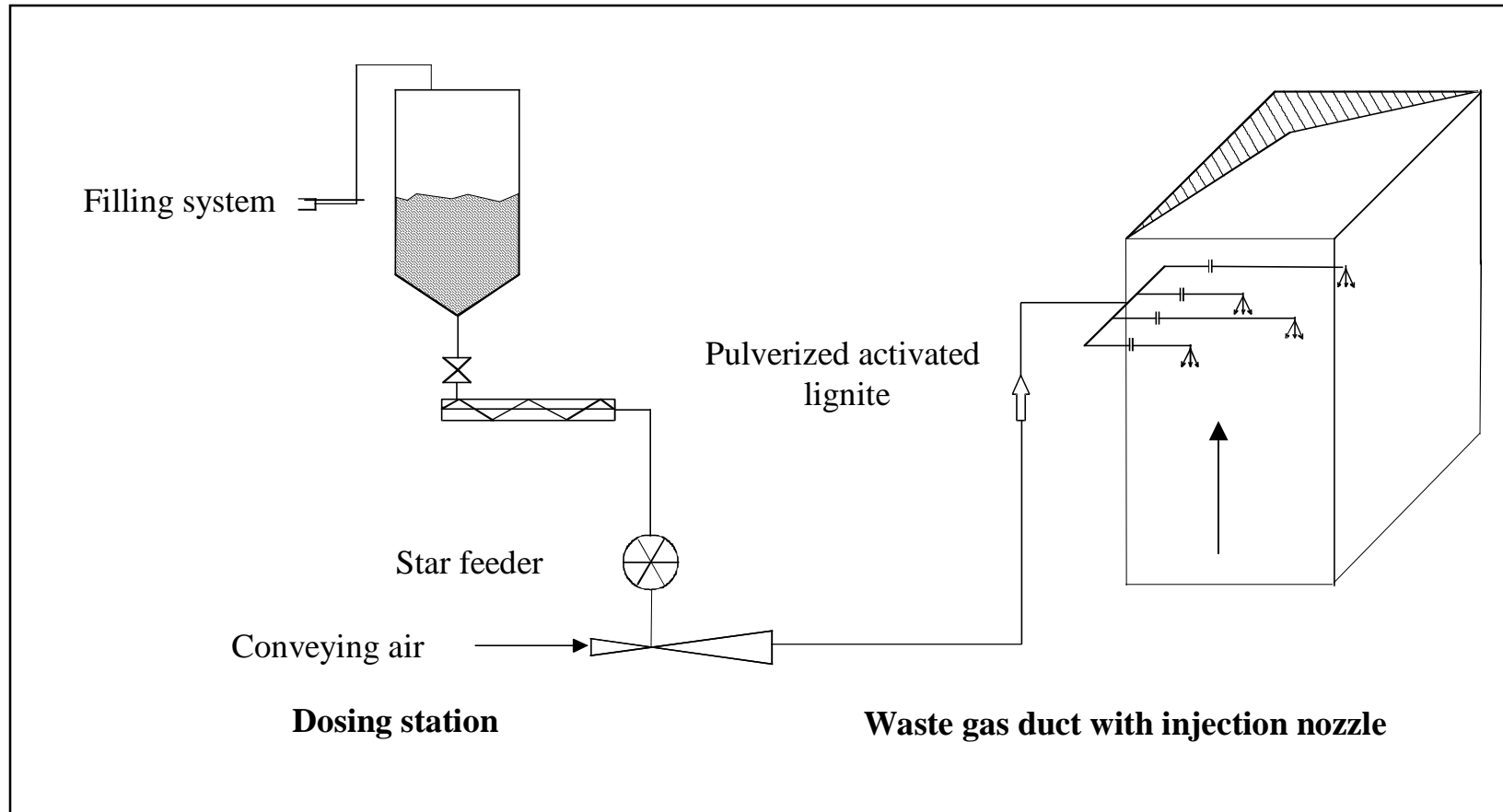


Mercury Control Based On Activated Lignite HOK Technology

- Operating Plants
 - Circulating Fluidized Bed Boilers
 - ESP PM Control
 - Fuel Lignite + Sewage Sludge
 - o Berrenrath
 - Dose Rate 6.3 lb/MMACFM
 - + 85% Hg removal
 - 1999
 - o Wachtberg
 - Dose Rate 8.9 lb/MMACFM
 - + 85% Hg removal
 - 2003



Typical Installation



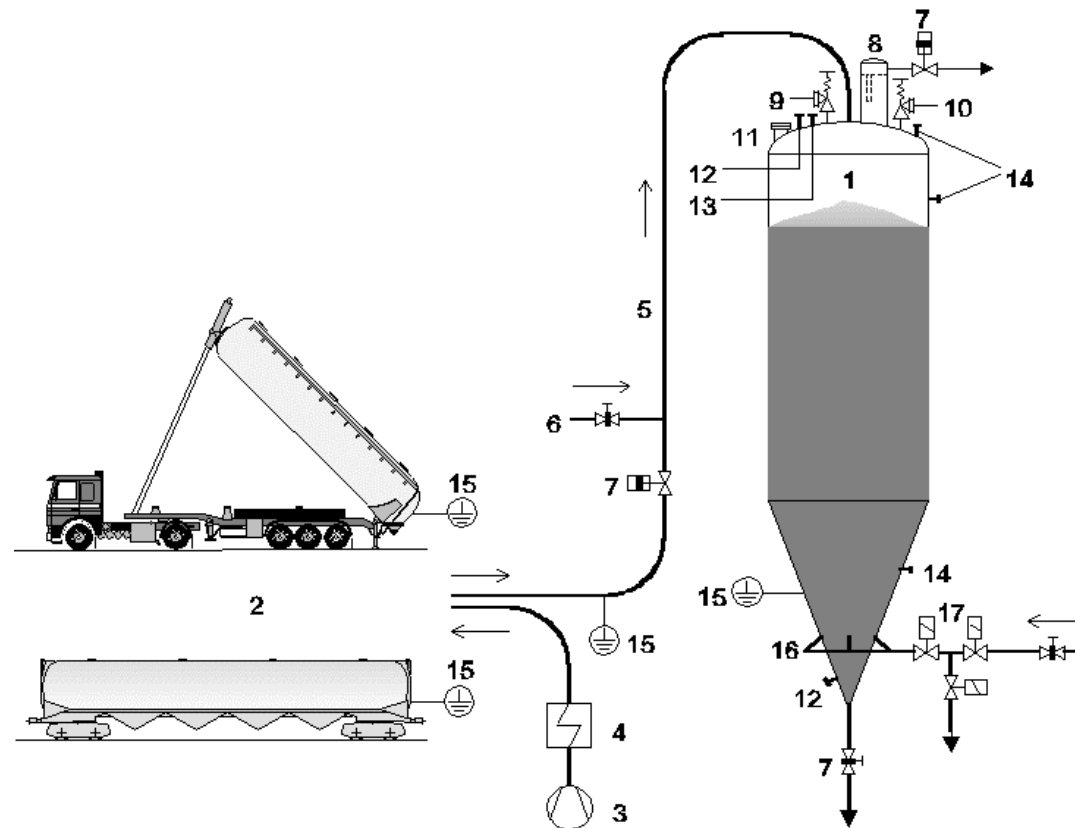


HOK Injection at the RWE Power Plant - Berrenrath



Pneumatic Transloading of HOK

- 1 silo
- 2 silotruck
- 3 compressor
- 4 stationary air cooler
- 5 conveyor pipe
- 6 inert gas connection
- 7 gate valve
- 8 silo filter
- 9 safety relief valve for excess pressure
- 10 safety relief valve for vacuum
- 11 manhole
- 12 temperature sensor
- 13 level indicator
- 14 level controll (high - low)
- 15 electrostatic grounding
- 16 loosening
- 17 double magnetic valve with deaeration





Conclusion

There is always safety issues when handling powdered products such a activated carbon and coal. Good engineering practices have been established for material handling to mitigate safety issues.